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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

July 24 - July 30, 1998

Summary 98-30

Operating Experience Weekly Summary 98-30

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EVENTS

1. FATALITY AT IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY TEST REACTOR AREA

On July 28, 1998, at the Idaho National Engineering and Environmental Laboratory Test Reactor Area, an electrician died after fire retardant (carbon dioxide) was accidentally discharged during scheduled electrical maintenance operations at the Test Reactor Area. Idaho Falls and Pocatello hospitals treated an additional 14 employees for exposure to carbon dioxide and released all but 3 of them. Of the workers who remained hospitalized, two were in critical condition and one was in serious condition. The cause of the accidental discharge and whether warning alarms sounded is not known. A Type A Accident Investigation is underway. No nuclear materials were involved, and there was no threat to public safety. OEAF engineers will follow the accident investigation and provide information as it becomes available. (ORPS Report ID--LITC-TRA-1998-0010)

KEYWORDS: carbon dioxide, electrical maintenance, fatality, fire retardant

FUNCTIONAL AREAS: Electrical Maintenance, Fire Protection, Industrial Safety

2. INCORRECT DEFAULT VALUES USED FOR DOSE CALCULATIONS AT SAVANNAH RIVER

On July 21, 1998, at the Savannah River H-Canyon Facility, a facility manager reported that Westinghouse personnel identified an incorrect facility safety analysis default assumption in the MELCOR Accident Consequence Code System (MACCS) used to calculate dose consequences. Investigators determined that the limiting radionuclide at H-Canyon is plutonium nitrate, but MACCS calculates dose consequences using a default radionuclide table for plutonium oxide. Investigators determined that dose consequence analyses results increase by approximately 50 percent when a plutonium nitrate radionuclide table is used instead of a plutonium oxide table. Westinghouse personnel are re-evaluating three accident scenarios to determine if the dose consequences remain within the facility authorization bases. The HB-Line facility manager has suspended transfers from the HB-Line Facility to prevent any additional increase in the H-Canyon Facility source term and to ensure that the facility is maintained in a safe configuration until Westinghouse personnel complete the evaluation. Westinghouse personnel will also determine if dose consequence analyses at any other facility or site could be affected by the MACCS default assumption. (ORPS Report SR--WSRC-HCAN-1998-0021)

Investigators determined that the chemical and biological effects of plutonium nitrate in the human body result in increased dose rates because it (1) goes into solution in the lungs, (2) reaches target organs faster, and (3) remains in the body longer than the oxide form. They also determined that increased residence time is the major contributor to increased dose rates. Investigators determined that all nitrates are soluble and typically result in higher dose conversion factors than other soluble material. Westinghouse personnel reviewed the H-Canyon accident consequence calculations and determined that three accident scenarios are affected: (1) a postulated earthquake that results in an off-site release, (2) an airborne release from a cooling tower tube and coil leak that results in an on-site release, and (3) an inadvertent transfer from the Canyon to the outside facilities that results in an on-site release. The facility manager and Westinghouse personnel will continue to review this event. The facility manager will develop corrective actions as necessary. OEAF engineers will continue to follow this event and will report any additional information in a future Weekly Summary.

NFS has reported on safety analysis deficiencies in several Weekly Summaries. Following are some examples.

- Weekly Summary 97-39 reported that the Facility Plant Review Committee at a Hanford reprocessing facility reported an unreviewed safety question because ventilation system modifications made in 1969 were not in accordance with the safety analysis report. The committee agreed that modifications would result in the collapse of the filters during a design basis fire, leading to an unfiltered radioactive release through the main stack. The failure of the filters did not match the accidents analyzed in the safety analysis report. (ORPS Reports RL--PHMC-324FAC-1997-0010 and RL--PHMC-324FAC-1997-0014)

- Weekly Summary 95-32 reported that, at Pacific Northwest Laboratories, the seismic response of a building had not been analyzed because of an error in a seismic analysis performed in 1990. The analyst used a computer program that can apply either velocity or acceleration spectrum data to model seismic response. The analyst used acceleration data, but omitted a switch value that caused the input to be treated as velocity data (the default). The resulting error was not detected by following quality control procedures, and the analysis was used as the basis for seismic qualification of the building. (ORPS Report RL--PNL-324-1995-0015)

- Weekly Summary 94-33 reported that at the Savannah River Receiving Basin for Off-site Fuels (RBOF) personnel observed that some of the fuel being stored at the facility was of a different type than specified in the safety analysis report. This prompted a review of the dose calculation methodology for the RBOF because the safety analysis report assumed a different fuel inventory for the fuel-rupture accident analysis. (ORPS Reports SR--WSRC-RBOF-1994-0009)

These events illustrate the importance of performing a thorough review of all accident assumptions as part of the facility safety analysis report. Analysis assumptions should be delineated in the facility authorization bases, so safety questions can be adequately evaluated and any operating assumptions can be translated into procedures. These events also point out the importance of verification and validation of software programs. These reviews are necessary to ensure that facilities are not operated or placed in unsafe conditions. In addition, periodic reviews of safety documentation should focus on analysis assumptions to ensure they remain valid under all conditions, especially when facilities change or add missions.

Facility managers should ensure that safety analyses are independently verified and audited to provide confidence that they adequately reflect operational, functional, and technical requirements. Personnel who perform accident analyses should have a thorough understanding of all code aspects, as these codes can be complex. Also, they should not use default parameters in their analyses without ensuring their validity for the scenario being evaluated. In this event, the person who performed the analysis should have been aware of the dependency of inhalation dose conversion factors on the solubility class of the material inhaled. Facility managers should also ensure that personnel responsible for reviewing and updating facility safety analysis reports verify that analysis data is accurately presented and that the analyzed hazards are the appropriate ones for the facility.

- DOE O 1330.1D, *Computer Software Management*, provides guidance for establishing a computer software management program, including quality assurance and quality control.

- DOE O 1360.4B, *Scientific and Technical Computer Software*, provides guidance for the management and control of scientific and technical software.

- DOE O 5480.23, *Nuclear Safety Analysis Reports,* states that it is DOE policy to analyze nuclear facilities and operations to (1) identify all hazards and potential accidents associated with the facility and the process systems, components, equipment, or structures; and (2) establish design and operational means to mitigate these hazards and potential accidents. The results of these analyses are to be documented in safety analysis reports. This Order also requires periodic review and updates of safety analysis reports to ensure that information is current and remains applicable.

- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports,* provides a graded approach to the preparation of safety analysis reports for nuclear facilities. The standard discusses the facility's stage in its life cycle and states that all safety analysis reports should furnish information about subsequent stages of the facility life cycle, including end-of-life decontamination and decommissioning.

- DOE/EH-0502, Safety Notice 95-02, "Independent Verification and Self-Checking," September 1995, provides guidance and good practices for performing independent verification. Safety Notice 95-02 can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Road, Germantown, MD 20874. Safety Notices are also available on the OEAF Home Page at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: safety analysis, accident analysis, authorization basis

FUNCTIONAL AREAS: Licensing/Compliance, Nuclear/Criticality Safety, Technical Support

3. UNQUALIFIED SUBCONTRACTOR ALTERS BOILER PIPING

On July 22, 1998, at the Idaho National Engineering and Environmental Laboratory, boiler inspectors discovered that a subcontractor that installed a new feed-water chemical injection system was not qualified to perform alterations on boiler systems. The subcontractor welded piping inside the boiler external piping envelope, which requires National Board of Boiler and Pressure Vessel Inspector certification. Repairs or alterations of boiler systems and pressure vessels performed by unqualified organizations or individuals increases the risk for personnel injury and equipment damage. (ORPS Report ID--LITC-LANDLORD-1998-0024)

The National Board accredits qualified organizations to perform repairs and alterations to pressure-retaining items and repairs to pressure-relief devices. The Board's "R" (repair), "VR" (repair of pressure-relief valves), and "NR" (nuclear repair) Certificates of Authorization and stamps indicate that a repaired or altered pressure-retaining item or pressure-relief device meets the requirements of the *National Board Inspection Code.*

Investigators determined that the design engineer who prepared the work package did not refer to the need for the R stamp for modifications to the boiler feed-water piping and that work package reviewers accepted the package. Projects Department personnel were also unaware of the R-stamp requirement and allowed an unqualified subcontractor to bid on and receive the work. The department manager ordered the boilers to be shut down after inspectors notified him of the lack of the R stamp on the modifications. The shutdown resulted in a loss of steam to the Idaho Nuclear Technology and Engineering Center. R-stamp-certified personnel inspected the work on July 22, 1998. They determined that all installation and safety requirements were met. Proposed corrective actions include updating boiler system drawings to show code boundaries and involving National Board certified inspectors in the planning stages of work on systems associated with boilers.

NFS has reported on inadequate piping and vessel weld quality assurance in several Weekly Summaries. Following are some examples, as well as a similar event reported in ORPS.

- Weekly Summary 97-12 reported that a construction welder at the Savannah River Site identified a weld attaching a nozzle to a tank that did not appear to comply with design drawings. Engineers and a welding inspector also inspected the weld and confirmed that it did not appear to be a full penetration as required by the design drawings. Investigators determined that neither the tank manufacturer's quality assurance programs nor the code inspector's review identified the welding deficiency and that receipt inspectors did not identify it because weld inspections were not specified. (ORPS Report SR--WSRC-CMD-1997-0004)

- Weekly Summary 92-32 reported that the Nuclear Regulatory Commission issued an information notice on welding defects in the fabrication of uranium hexafluoride cylinders when a licensee discovered attached welds on cylinder valve and plug couplings rather than full-penetration welds as required by the purchase order specification. Ultrasonic testing showed that 11 out of 15 cylinders had coupling welds that lacked full penetration. (NRC Information Notice 92-58, "Uranium Hexafluoride Cylinders - Deviations in Coupling Weld")

- On May 31, 1995, workers at the Oak Ridge National Laboratory detected a leak in the liquid low-level waste underground transfer pipeline. Investigators determined that the leak was caused by a defective weld in the pipe. The facility manager determined that the root cause of the leak was a lack of a quality assurance program to verify that the construction and installation of the pipeline was appropriate for the waste that was to be transferred through the line. (ORPS Report ORO--MMES-X10WSTEMRA-1995-0001)

This event underscores the importance of good piping and vessel modification practices, including determination of the certification requirements for subcontractors. Good management practices should include clearly identifying subcontractor certification requirements; verifying subcontractor qualifications; and ensuring the quality of recordkeeping, inspections, and examinations. The following references should be used by managers responsible for projects involving modifications to piping systems and vessels.

- ASME Standard B31.1, *Power Piping*, provides the engineering requirements that are necessary and adequate for safe design, construction, examination, inspection, and testing of power piping systems. This standard, in conjunction with the ASME Boiler and Pressure Vessel Code, also provides requirements for qualifications of welders and inspectors.

- *ASME Code Simplified: Power Boilers,* explains code aspects related to the boiler and pressure vessel codes and groups related requirements from different code paragraphs in one place.

- DOE O 5700.6C, *Quality Assurance*, includes inspection and acceptance testing criteria. The criteria state that a process should be established and implemented to specify when and what type of inspections are required. Inspections must be conducted using established acceptance and performance criteria, and equipment used for inspections and tests must be calibrated and maintained.

Additional information regarding construction, installation, repair, maintenance, and inspection of boilers and pressure vessels is available from the National Board of Boiler and Pressure Vessel Inspectors. The National Board's URL is http://nationalboard.org.

Additional standards for welder qualifications and inspections, as well as information on a wide variety of welding topics, are available from the American Welding Society (AWS). AWS standards have been adopted by ANSI. The Society's URL is http://www.amweld.org/.

KEYWORDS: inspection, certification, welding

FUNCTIONAL AREAS: Construction, Training and Qualifications

FINAL REPORT

This section of the OE Weekly Summary discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. COMPRESSOR FAILURE AT MOUND

This week OEAF engineers reviewed a final occurrence report about the failure of a compressor at the Mound Tritium Emissions Reduction Facility. On October 8, 1997, the compressor automatically shut down, and an operator attempted to restore it to service. When he restarted the compressor, the operator observed that the oil pressure was low and heard a loud, knocking noise. A low-oil-pressure cutout switch failed to stop the compressor, so the operator manually shut it down. Investigators learned later that the cutout switch was improperly wired. Facility

personnel removed the compressor from service, and mechanics completely disassembled and inspected it. They replaced the lower drive assembly and rebuilt the rest of the compressor. During the repair and rebuilding of the compressor and a subsequent investigation, facility personnel identified several deficiencies that were the result of work performed during the original construction and installation of the compressor. They also identified several conduct of operations issues and causes that contributed to a loss of lube oil and eventual failure of the compressor. (OEWS 98-04 and ORPS Report OH-MB-BWO-BWO01-1998-0001, mapped from OH-MB-EGGM-EGGMAT01-1998-0001)

Based on the operator's observations in October 1997, facility personnel suspected that the compressor lower drive assembly was damaged. In January 1998, they confirmed the damage and concluded that it probably occurred because the compressor was operated with low oil pressure. Investigators learned that lubricating oil is normally pulled out of the compressor crankcase by a seal pump-out assembly through a throttle valve that is positioned to regulate the amount of oil removed. During their investigation they determined that the throttle valve was open too far and an excessive amount of oil was being removed from the crankcase. They also determined that the low-oil-pressure cutout switch, which was supposed to automatically shut down the compressor on low oil pressure, was improperly wired. Investigators concluded that the switch was probably wired incorrectly during initial construction and installation of the compressor.

Because the compressor was severely damaged, facility personnel performed a root cause analysis and conducted a detailed investigation. They identified direct, root, and several contributing causes. During their investigation they determined that several things went wrong that eventually led to the failure of the compressor. Following is a summary of their findings.

Direct Cause—The facility manager reported that the direct cause of the event was personnel error (other human error) because facility operators had not properly positioned the seal pump-out throttle valve. This error occurred because they were not knowledgeable in the operation of the seal pump-out system. Because the throttle valve was open too far, an excessive amount of oil was pulled from the compressor crankcase, resulting in a low-oil-pressure condition. Investigators also determined that facility personnel had previously performed maintenance on the compressor and the valve could have been mis-positioned at that time.

The facility manager reported several contributing causes for the event.

- **Training Deficiency, No Training Provided—**The facility operators did not properly position the seal pump-out throttle valve because they had not been trained on the operation of the seal pump-out system. Therefore, the operators positioned the valve "open" instead of the correct position of "throttled."

- **Design Problem, Specification Error—**The low-pressure cutout switch did not function to automatically shut down the compressor because the design engineer did not verify the requirements for wiring the switch. Because he had not verified them, he did not include detailed instructions in the installation instructions.

- **Personnel Error, Inattention to Detail—**The facility manager reported that the design engineer did not pay attention to detail because he did not identify a requirement to test the low-pressure cutout switch as recommended by the supplier. The switch was not tested during the installation of the compressor or at any time afterwards.

- **Design Problem, Inadequate or Defective Design—** Investigators determined that facility operators could not monitor the oil level in the compressor crankcase because it did not have an oil-level dipstick. They learned that the design engineer had removed the dipstick during the original design and used the tube for an oil-fill system without providing an alternate means of checking the oil level.

- **Management Problem, Inadequate Supervision—** Investigators learned that facility personnel had constructed a contamination containment tent to perform maintenance on a nearby glovebox. The location of the tent prevented the operators from being able to see an oil pressure gage on the compressor. The facility manager reported that supervisors did not provide adequate instructions for installation of the tent.

- **Personnel Error, Communication Problem—** Investigators determined that facility operators wrote in their log book that they could not monitor the compressor oil pressure because the containment tent blocked the pressure gage. However, they did not inform their supervisors of this problem. The facility manager also reported that supervisors failed to review their log book in a timely manner. If they had performed a timely review, the supervisors would have been aware of the oil-pressure monitoring problem.

Root Cause—The facility manager reported management problem (other management problem) as the root cause. Investigators determined that a management problem was a factor in the lube oil being pulled from the crankcase and in the low-oil-pressure cutout switch not operating. They determined that, because managers did not review the valve line-up forms for accuracy and completeness, the throttle valve position was listed as “open” instead of “throttled.” They also determined that managers had not verified the completeness of the training provided to operators for the seal pump-out system or the completeness of the test procedure for the cutout switch.

In the occurrence report, the facility manager concluded that had any one of the causes been prevented, the likelihood of the event occurring would have been very small. He also stated that (1) if the operators had been able to perform their daily checks of the oil pressure gage, they could have manually shut down the compressor when low oil pressure was indicated; (2) if the cutout switch had been operable, it would have automatically shut down the compressor before it was damaged; and (3) if the throttle valve had been in the correct position, the lube oil would have remained in the crankcase.

The investigating team recommended implementing several actions, including corrective actions, to prevent a recurrence of the event. Following is a summary of these actions.

- Facility personnel rewired and tested the low-oil-pressure cutout switch. They also established a test program to routinely test the switch.

- Facility personnel installed an oil-level dipstick.

- Facility personnel installed a tag, indicating the proper operating position, on the seal pump-out assembly throttle valve.

- Facility personnel performed a complete review of the compressor installation to determine if other deficiencies exited. They also checked another compressor to determine if similar conditions on it needed to be corrected.

- Training personnel updated the facility training plan with sessions specific to the seal pump-out system. Facility managers also reviewed the plan for completeness.

- The facility manager counseled supervisors on the importance of (1) checking the accuracy of valve line-up checks when returning equipment to service, (2) reviewing and acting on entries written in log books, and (3) providing adequate installation instructions for containment tents. The facility manager also counseled the operators on the importance of communicating problems to their supervisors.

- The facility manager also provided copies of the final occurrence to all the area engineers and design engineers so they could learn the importance of not removing equipment design features without providing compensatory measures when making design changes.

This event illustrates the consequences of a breakdown in conduct of operations controls and the failure to properly review and manage modifications made to equipment and systems. It also underscores the importance of testing and inspecting equipment during installation or after maintenance has been performed.

Facility managers should review the guidance in DOE O 5700.6C, *Quality Assurance*, which specifies the criteria for procurement, inspection, and acceptance testing. The inspection and acceptance testing criteria state that a process should be established and implemented to specify when and what type of inspection is required. Guidance for receipt inspections can also be found in DOE-STD-1070-93, *Guidelines to Good Practices for Procurement of Parts, Materials, and Services at DOE Nuclear Facilities*, and DOE-STD-1071-94, *Guidelines to Good Practices for Material Receipt, Inspection, Handling, Storage, Retrieval, and Issuance at DOE Nuclear Facilities*.

DOE O 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The Order states that work control procedures help personnel understand the necessary requirements and controls. Section 3.4 identifies the elements of a maintenance management program that ensure planning, control, and documentation of maintenance. Work control managers at DOE facilities should review their programs to ensure that engineers and craftsmen understand their responsibilities and obligations. DOE-STD-1050-93, *Guideline to Good Practices for Planning, Scheduling, and Coordination of Maintenance at DOE Nuclear Facilities*, provides information on work controls and work coordination.

DOE-STD-7501-95, *Development of DOE Lessons Learned Programs*, defines basic elements and concepts for site lessons learned programs. All managers should incorporate both site-specific lessons learned and those gained through DOE-wide operating experiences into their work process and work control procedures.

DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter VIII, "Control of Equipment and System Status," states that DOE facilities are required to establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing activities.

KEYWORDS: training, modifications, conduct of operations, acceptance testing

FUNCTIONAL AREAS: Conduct of Operations, Configuration Control